

Amendments to the Drawings

Replacement Sheets for Figures 1, 5, 10, and 15 have been submitted to overcome the drawing objections.

REMARKS

Claims 1-4, 6-14, and 16-33 are pending. Claims 4, 6, 7, and 14 have been amended, claims 5 and 15 have been canceled, and new claims 31-33 have been added to recite additional features of the embodiments disclosed in the specification. In addition, Replacement Sheets for Figures 1 5, 10, and 15 have been submitted and the specification has been amended to overcome the Examiner's objections.

In Office Action, the drawings were found to be objectionable for containing typographical errors. Annotated sheets correcting these errors have been submitted with this paper. Replacement sheets will soon be filed.

Concerning the duplicate use of 32 in Figure 2. Applicants submit that 32 is not a reference numeral in this figure, but rather has been used to indicate the number of bits corresponding to control signals IP_i and QP_i . (This is also apparent from the slash through the signal lines which is customarily used to indicate a number of bits, and the disclosure of bit information on page 22 of the specification.) The four sampled data bits ($DRI+$, $DRI-$, $DRQ+$, $DRQ-$) have been shown in revised Figure 10.

As for the objections to the specification, it is submitted that the difference angle is clear when read in view of the drawings and other portions of the specification.

Claims 1-3, 8-15, and 25-29 were rejected under 35 USC § 102(b) for being anticipated by the Becker patent. This rejection is traversed for the following reasons.

Claim 1 recites a "first interpolator to adjust a phase of an in-phase signal" and "a second interpolator to adjust a phase of a quadrature signal." The Becker patent does not disclose these features.

The Becker patent discloses a timing loop 60 which generates signals for controlling two interpolation circuits. As shown in Figure 2, the first interpolation circuit 50 receives an in-phase (I) component of a received signal and the second interpolation circuit 50 receives a quadrature (Q) component of the received signal. However, circuits 50 do not adjust phases of the I and Q received signals. Rather, the interpolation circuits of Becker perform time shifts and frequency adjustments of the I and Q signals, so that the outputs of circuits 50 are time-position locked to symbol locations of the received signal. (This is clear from Figure 3 of Becker where shifts are performed relative to the time axis - compare this, for example, to the non-limiting embodiment of Figure 7 of Applicant's drawings where the phase of at least the Q signal is shifted to correspond to point "C" on the eye diagram.)

These differences are clear from columns 5 and 6 of the Becker patent. At column 5, Becker discloses that the interpolation circuits perform two key functions. First, to produce a resampled signal having twice the frequency of the symbol data rate to prevent aliasing. And second, to ensure that the resampled signal is time-position locked to the baseband signal, so that the samples are taken at symbol locations of the baseband signal. (See lines 51-65).

At column 6, Becker goes on to explain that each interpolator circuit 50 includes an interpolator 80 which interpolates between the points of the output stream 48 (based on time displacements), to produce an output frequency that matches a sampling frequency, f_s . By using appropriate time displacements, each circuit 50 produces sampled interpolation points that correspond to symbol locations in the received signal. (See lines 18-52).

Thus, interpolators 50 do not perform the functions of adjusting the phases of in-phase and quadrature signals. Becker, therefore, does not teach or suggest the first and second phase interpolators of claim 1. Moreover, while timing loop 60 generates signals for separately controlling circuits 50, Becker does not disclose that circuits 50 adjust the

quadrature signal phase independently from the phase adjustment of the in-phase signal, as is further recited in claim 1.

Because the Becker patent does not disclose all the features of claim 1, Applicant submits that Becker does not anticipate this claim. Furtherance of claim 1 and its dependent claims to allowance is therefore respectfully requested.

Dependent claim 2 recites that “a non-orthogonal relationship exists between the adjusted phases of the quadrature and in-phase signals.” The interpolators 50 of Becker perform time shifts and frequency adjustments, not phase adjustments in the manner recited in claim 1. Consequently, Becker does not disclose adjusting the phases of I and Q signals to be non-orthogonal to one another.

This is an especially advantageous feature of the invention because, for example, it allows the Q signal to be out of phase (relative to the standard 90° phase difference) with the I signal in order to achieve an optimal position for data sampling that reduces or minimizes bit-errors in the receiver. None of these features are disclosed by Becker. Accordingly, it is submitted that claim 2 is allowable, not only by virtue of its dependency from claim 1 but also based on the features separately recited therein.

Dependent claim 3 recites that “the second interpolator adjusts the quadrature signal phase based on one or more predetermined increments.” Becker does not disclose these features, e.g., Becker only discloses performing incremental time shifts (see Figure 3), not phase adjustments as recited in claim 3.

Claim 10 recites “a phase adjuster to adjust a phase of the quadrature signal independently from a phase of the in-phase clock signal, wherein the adjusted phase of the quadrature signal corresponds to a clock signal.” Becker does not disclose these features. Accordingly, claim 10 and its dependent claims are allowable.

Dependent claim 11 recites that “a non-orthogonal relationship exists between the phases of the quadrature and in-phase signals after said adjustment,” and dependent claim 12 recites that “the phase adjuster adjusts the quadrature signal phase based on one or more predetermined increments.” These features are also not disclosed by Becker.

Claim 14 recites “adjusting a phase of the quadrature signal independently from a phase of the in-phase signal, wherein said adjusting results in a non-orthogonal relationship between the phases of the quadrature and in-phase signals.” As explained above, Becker does not disclose these features. Applicant therefore submits that claim 14 and its dependent claims are allowable.

Claim 26 recites features similar to those that patentably distinguish claim 1 from the Becker patent. Applicant therefore submit that claim 26 and its dependent claims are allowable.

Claims 4-7 and 16-24 were rejected under 35 USC § 103(a) for being obvious in view of a Becker-Lee combination. This rejection is traversed, in part, on grounds that the Lee patent does not teach or suggest the features of base claim 1 missing from the Becker patent.

The Lee patent discloses using two phase interpolators 29a and 29b to generate I and Q phase clock signals. The clock signals (CKI and CKQ) are adjusted so that their edges are aligned with the transition portion between two data bits, D0 and D1. (See column 3, lines 41-50 with reference to Figure 3.). However, the phases of clock signals CKI and CKQ are not independently adjusted as required by base claim 1. Rather, Lee discloses that the clock signals must be 90° out-of-phase with one another. (See column 4, lines 35-37).

As a result of this 90° phase relationship, setting the phase of the I signal will automatically result in setting the phase of the Q signal, i.e., once the I phase is set, the Q phase is 90° from this phase. (See Figure 5(a)). By requiring a 90° phase difference between the I and Q clock signals, it is clear that the Lee patent does not teach or suggest a “second interpolator [that] adjusts the quadrature signal phase independently from the phase adjustment of the in-phase signal performed by the first interpolator” as recited in claim 1. (Emphasis added). Applicant therefore submits that claim 4 is allowable at least by virtue of its dependency from claim 1.

Dependent claim 6 separately recites that “the second interpolator adjusts the phase of the quadrature signal to coincide with a second predetermined point on an eye diagram, the phase of the quadrature signal at the second predetermined point adjusted by the second interpolator to be non-orthogonal to the phase of the in-phase signal at said first predetermined point on the eye diagram.”

The Lee patent does not teach or suggest these features, i.e., as indicated above Lee requires its I and Q clock signals to maintain a 90° phase separation. Neither phase interpolator of Lee adjusts the phase of the Q signal to intentionally be non-orthogonal to the I signal phase relative to respective points on an eye diagram. Applicant therefore submits that claim 6 is allowable, not only by virtue of its dependency from claims 1 and 4 but also based on the features separately recited therein.

Claim 7 recites that “the second predetermined point is a widest point on the eye diagram.” When the Q signal phase corresponds to this point, in accordance with one non-limiting embodiment data sampling optimally occurs and the receiver operates at a reduced or minimized bit-error rate. The Lee patent does not teach or suggest the features of claim 7

Claims 16-19 are allowable for reasons similar to those mentioned above.

Claim 20 recites that adjusting the quadrature signal phase includes “mapping a phase of the quadrature signal onto an eye diagram of the data signal; determining a difference between the phase of the quadrature signal and a phase which coincides with a first point on the eye diagram; and adjusting the quadrature signal phase to reduce said difference.” These features are not taught or suggested by Lee or Becker, whether taken alone or in combination.

Claim 21 recites that “the quadrature signal phase is adjusted to at least substantially eliminate said difference.” These features are not taught or suggested by Lee or Becker, whether taken alone or in combination.

Claim 22 recites that “the quadrature signal phase is adjusted in one or more predetermined increments to reduce said difference.” These features are not taught or suggested by Lee or Becker, whether taken alone or in combination.

Claim 23 recites that the first point is a widest point on the eye diagram. These features are not taught or suggested by Lee or Becker, whether taken alone or in combination.

Claim 24 recites that “adjusting the quadrature signal phase to reduce said difference does not change the phase of the in-phase signal.” These features are not taught or suggested by Lee or Becker, whether taken alone or in combination. In fact, Lee teaches away from these features by disclosing a constant 90 degree phase relationship between its I and Q clock signals.

New claims 31-33 have been added to the application.

Claim 31 recites that “the second interpolator adjusts the phase of the quadrature signal to the second predetermined point by one or more predetermined phase increments.”

These features are not taught or suggested by Lee or Becker, whether taken alone or in combination.

Claim 32 recites that “a difference between the phase of the in-phase signal at the first predetermined point and the phase of the quadrature signal at the second predetermined point corresponds to said one or more predetermined phase increments.” These features are not taught or suggested by Lee or Becker, whether taken alone or in combination.

Claim 33 recites “sampling the in-phase and quadrature phase signals based on the independently adjusted phases of the in-phase and quadrature signals.” These features are not taught or suggested by Lee or Becker, whether taken alone or in combination.

In view of the foregoing amendments and remarks, it is respectfully submitted that the application is in condition for allowance. Favorable consideration and timely allowance of the application is respectfully requested.

To the extent necessary, Applicants petition for an extension of time under 37 CFR § 1.136. Please charge any shortage in fees due in connection with this application to Deposit Account No. 16-0607 and credit any excess fees to the same Deposit Account.

Respectfully submitted,



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